

extracted at said extraction step; and

an embedding step of altering the image in accordance with watermark information and embedding the watermark information on the basis of the vector

5 information.

4. The method according to claim 3, wherein the vector information is 8-dimension vector information indicating whether there are eight pixels neighboring a pixel of

10 interest.

5. An image processing apparatus for processing a binary image input thereto, comprising:

arithmetic means for obtaining an average of
15 pattern scores of a target binary image based upon the
target binary image and first principal component values
of a reference pattern;

comparison means for comparing the average of
pattern scores of the target binary image and a
reference-pattern score that is based upon a sum total
of distances between a first principal component
direction of the reference pattern and a standard
vector;

translation means for translating feature vector
25 space of the target binary image in accordance with
result of the comparison by said comparison means and

access control information to be embedded in the target binary image; and

altering means for altering the target binary image based upon a result obtained by translating the feature vector space.

6. The apparatus according to claim 5, wherein the average of pattern scores of the target binary image is obtained based upon the following equation:

$$zz1^* = (a11\mu1^* + a12\mu2^* + a13\mu3^* + a14\mu4^* + a15\mu5^* + a16\mu6^* + a17\mu7^* + a18\mu8^*)/p;$$

where $a11, \dots, a18$ represent first principle components of the reference pattern, $\mu1^*, \dots, \mu8^*$ represent component values of pattern feature space of a standardized binary image, and p represents a number of pixels in the pattern feature space of the binary image.

7. The apparatus according to claim 5, wherein said translation means translates the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

8. The apparatus according to claim 5, wherein the reference-pattern score is obtained based upon the following equation:

$$z1^* = a11x1^* + a12x2^* + a13x3^* + a14x4^* + a15x5^* + a16x6^* + a17x7^* + a18x8^*;$$

where $a11, \dots, a18$ represent first principle components of the reference pattern and $x1^*, \dots, x8^*$ represent component values of a standardized standard vector.

9. The apparatus according to claim 5, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

10. The apparatus according to claim 5, wherein said translation means translates the feature vector space in such a manner that the average of pattern scores of the target binary image will exceed the reference-pattern score by a predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the sum of the reference-pattern score and the predetermined amount will exceed the average of pattern scores of the target binary image when a logic value of the access control information is "1".

11. The apparatus according to claim 5, further comprising printing means for printing based upon image

data corresponding to the target binary image that has been altered by said altering means.

12. The apparatus according to claim 5, further comprising:

extraction means for reading a document image formed based upon the target binary image that has been altered by said altering means, and extracting an outline of this image;

means for obtaining an average of pattern scores of an image that corresponds to the outline;

difference calculation means for obtaining a difference between the reference-pattern score, which is based upon a sum total of distances between the first principle component direction of the reference pattern and the standard vector, and the average of pattern scores; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation means.

13. An image processing apparatus comprising:

extraction means for reading a document image and extracting an outline of the image;

means for obtaining an average of pattern scores of

within a predetermined range; and

altering means for altering the target binary image based upon a result obtained by moving the vector space of the feature quantity.

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15. The apparatus according to claim 14, wherein said calculation means includes:

outline extraction means for extracting an outline of the target binary image; and

10 dividing means for dividing the outline, which has been extracted by said outline extraction means, into a plurality of blocks;

said calculation means calculating a pattern vector of each of the plurality of blocks.

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16. The apparatus according to claim 15, wherein said moving means assigns each bit of the access control information, which has been input by said input means, to each block obtained by division by said dividing

20 means, and moves the feature vector space in such a manner that the correlation coefficient r will satisfy the relation $-\text{def} < r < \text{def}$ when the particular bit is "0" and in such a manner that the correlation coefficient r will satisfy the relation $-1 \leq r < -\text{def}$ or $\text{def} \leq r \leq 1$ when the particular bit is "1".

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17. The apparatus according to claim 14, wherein said
moving means moves the feature vector space in a
direction in which there is an increase in the value of
each element of the feature vector of the target binary
5 image.

18. The apparatus according to claim 14, wherein the
feature space is a set of vector information indicating
whether each pixel in an outline image of the target
10 binary image has a neighboring pixel.

19. The apparatus according to claim 14, further
comprising printing means for printing based upon image
data corresponding to the target binary image that has
15 been altered by said altering means.

20. The apparatus according to claim 14, further
comprising:

extraction means for reading a document image
20 formed based upon the target binary image that has been
altered by said altering means, and extracting an
outline of this image;

means for obtaining a pattern vector of an image
that corresponds to the outline; and

25 detection means for detecting the access control
information, which has been embedded in the document

image, in accordance with the correlation coefficient r , which has been calculated by said arithmetic means, between the pattern vector and the reference-pattern vector.

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21. An image processing apparatus comprising:

extraction means for reading a document image and extracting an outline of the image;

means for obtaining a pattern vector of an image
10 that corresponds to the outline;

correlation-coefficient arithmetic means for obtaining a correlation coefficient between a pattern vector of a reference pattern and the pattern vector of the image; and

15 detection means for detecting control information, which has been embedded in the document image, in accordance with the correlation coefficient obtained by said correlation-coefficient arithmetic means.

20 22. An image processing apparatus for processing a binary image input thereto, comprising:

arithmetic means for obtaining a first Mahalanobis distance between feature space of a target binary image and a standard vector;

25 comparison means for comparing the Mahalanobis distance of the target binary image and a second

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Mahalanobis distance between feature space of a
reference pattern and the standard vector;

translation means for translating a feature vector
space of the target binary image in accordance with
5 result of the comparison by said comparison means and
access control information to be embedded in the target
binary image; and

altering means for altering the target binary image
based upon a result obtained by translating the feature
10 vector space.

23. The apparatus according to claim 22, wherein the
first Mahalanobis distance between the target binary
image and standard vector is obtained based upon the
15 following equation:

$$D2 = (x-\mu)' \Sigma^{-1}(x-\mu)$$

where x represents the standard vector, μ denotes
an average vector of the reference-pattern feature
space, Σ^{-1} denotes an inverse matrix of a covariance
20 matrix of the reference-pattern feature space and D2
denotes the Mahalanobis distance between the standard
vector x and the average vector μ of the reference-
pattern feature space.

24. The apparatus according to claim 22, wherein said
translation means translates the feature vector space in

predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the first Mahalanobis distance will be less than the sum of the second
5 Mahalanobis distance and the predetermined amount when a logic value of the access control information is "1".

28. The apparatus according to claim 22, further comprising printing means for printing based upon image
10 data corresponding to the target binary image that has been altered by said altering means.

29. The apparatus according to claim 22, further comprising:
15 extraction means for reading a document image formed based upon the target binary image that has been altered by said altering means, and extracting an outline of this image;

distance calculation means for obtaining the
20 Mahalanobis distance between pattern feature space of the image that corresponds to the outline, and the standard vector; and

detection means for detecting the access control information, which has been embedded in the document
25 image, in accordance with the Mahalanobis distance, which has been obtained by said distance calculation

means, and the first Mahalanobis distance.

30. An image processing apparatus comprising:

extraction means for reading a document image and
5 extracting an outline of the image;

first distance calculation means for obtaining a first Mahalanobis distance between feature space of an image, which corresponds to the outline, and a standard vector;

10 second distance calculation means for obtaining a second
Mahalanobis distance between a reference-pattern feature
space and the standard vector;

difference calculation means for obtaining the
difference between the first and second Mahalanobis
15 distances; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation means.

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31. An image processing method for processing an input binary image, comprising:

an arithmetic step of obtaining an average of pattern scores of a target binary image based upon the target binary image and first principal component values of a reference pattern;

33. The method according to claim 31, wherein said translation step translates the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target
5 binary image.

34. The method according to claim 31, wherein the reference-pattern score is obtained based upon the following equation:
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$$z1^* = a11x1^* + a12x2^* + a13x3^* + a14x4^* + a15x5^* + a16x6^* + a17x7^* + a18x8^*;$$

where $a11, \dots, a18$ represent first principle components of the reference pattern and $x1^*, \dots, x8^*$ represent component values of a standardized standard
15 vector.

35. The method according to claim 31, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the
20 target binary image has a neighboring pixel.

36. The method according to claim 31, wherein said translation step translates the feature vector space in such a manner that the average of pattern scores of the
25 target binary image will exceed the reference-pattern score by a predetermined amount when a logic value of

the access control information is "0", and translates the feature vector space in such a manner that the sum of the reference-pattern score and the predetermined amount will exceed the average of pattern scores of the target binary image when a logic value of the access control information is "1".

37. The method according to claim 5, further comprising printing means for printing based upon image data corresponding to the target binary image that has been altered by said altering means.

38. The method according to claim 31, further comprising:

an extraction step of reading a document image formed based upon the target binary image that has been altered at said altering step, and extracting an outline of this image;

a step of obtaining an average of pattern scores of an image that corresponds to the outline;

a difference calculation step of obtaining a difference between the reference-pattern score, which is based upon a sum total of distances between the first principle component direction of the reference pattern and the standard vector, and the average of pattern scores; and

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a detection step of detecting control information,
which has been embedded in the document image, in
accordance with the difference obtained by said
difference calculation step.

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39. An image processing method comprising:

an extraction step of reading a document image and
extracting an outline of the image;

10 a step of obtaining an average of pattern scores of
an image that corresponds to the outline;

a difference calculation step of obtaining a
difference between a reference-pattern score, which is
based upon a sum total of distances between a first
principal component direction of a reference pattern and
15 the standard vector, and the average of pattern scores;
and

a detection step of detecting control information,
which has been embedded in the document image, in
accordance with the difference obtained at said
20 difference calculation step.

40. An image processing method for processing an input
binary image, comprising:

25 a calculation step of calculating a pattern vector
of a target binary image;

an arithmetic step of calculating a correlation

information, which has been input at said input step, to each block obtained by division at said dividing step, and moves the feature vector space in such a manner that the correlation coefficient r will satisfy the relation
5 $-\text{def} < r < \text{def}$ when the particular bit is "0" and in such a manner that the correlation coefficient r will satisfy the relation $-1 \leq r < -\text{def}$ or $\text{def} \leq r \leq 1$ when the particular bit is "1".

10 43. The method according to claim 40, wherein said moving step moves the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

15 44. The method according to claim 40, wherein the feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

20 45. The method according to claim 40, further comprising a printing step of printing based upon image data corresponding to the target binary image that has been altered at said altering step.

25 46. The method according to claim 40, further

comprising:

an extraction step of reading a document image
formed based upon the target binary image that has been
altered at said altering step, and extracting an outline
5 of this image;

a step of obtaining a pattern vector of an image
that corresponds to the outline; and

a detection step of detecting the access control
information, which has been embedded in the document
10 image, in accordance with the correlation coefficient r ,
which has been calculated at said arithmetic step,
between the pattern vector and the reference-pattern
vector.

47. An image processing method comprising:

an extraction step of reading a document image and
extracting an outline of the image;

a step of obtaining a pattern vector of an image
that corresponds to the outline;

20 a correlation-coefficient arithmetic step of
obtaining a correlation coefficient between a pattern
vector of a reference pattern and the pattern vector of
the image; and

a detection step of detecting control information,
25 which has been embedded in the document image, in
accordance with the correlation coefficient obtained at

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said correlation-coefficient arithmetic step.

48. An image processing method for processing an input binary image, comprising:

5 an arithmetic step of obtaining a first Mahalanobis distance between feature space of a target binary image and a standard vector;

10 a comparison step of comparing the Mahalanobis distance of the target binary image and a second Mahalanobis distance between feature space of a reference pattern and the standard vector;

15 a translation step of translating a feature vector space of the target binary image in accordance with result of the comparison at said comparison step and access control information to be embedded in the target binary image; and

20 an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

49. The method according to claim 48, wherein the first Mahalanobis distance between the target binary image and standard vector is obtained based upon the following equation:

25
$$D2 = (x-\mu)' \Sigma^{-1}(x-\mu)$$

where x represents the standard vector, μ denotes

an average vector of the reference-pattern feature space, Σ^{-1} denotes an inverse matrix of a covariance matrix of the reference-pattern feature space and D2 denotes the Mahalanobis distance between the standard
5 vector x and the average vector μ of the reference-pattern feature space.

50. The method according to claim 48, wherein said translation step translates the feature vector space in
10 a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

51. The method according to claim 48, wherein the
15 second Mahalanobis distance between the reference-pattern feature space and the standard vector is obtained based upon the following equation:

$$D2 = (x - \mu)^T \Sigma^{-1} (x - \mu)$$

where x represents the standard vector, μ denotes
20 an average vector of an observation-pattern feature space, Σ^{-1} denotes an inverse matrix of a covariance matrix of the observation-pattern feature space and D2 denotes the Mahalanobis distance between the standard vector x and the average vector μ of the observation-
25 pattern feature space.

52. The method according to claim 48, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

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53. The method according to claim 48, wherein said translation step translates the feature vector space in such a manner that the first Mahalanobis distance will exceed the second Mahalanobis distance by a
10 predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the first Mahalanobis distance will be less than the sum of the second Mahalanobis distance and the predetermined amount when a
15 logic value of the access control information is "1".

54. The method according to claim 48, further comprising a printing step of printing based upon image data corresponding to the target binary image that has
20 been altered at said altering step.

55. The method according to claim 48, further comprising:

an extraction step of reading a document image
25 formed based upon the target binary image that has been altered at said altering step, and extracting an outline

accordance with the difference obtained at said difference calculation step.

57. A computer-readable storage medium storing a
5 program for executing an image processing method for processing an input binary image, said storage medium comprising:

10 a module for an arithmetic step of obtaining an average of pattern scores of a target binary image based upon the target binary image and first principal component values of a reference pattern;

15 a module for a comparison step of comparing the average of pattern scores of the target binary image and a reference-pattern score that is based upon a sum total of distances between a first principal component direction of the reference pattern and a standard vector;

20 a module for a translation step of translating feature vector space of the target binary image in accordance with result of the comparison by the module for said comparison step and access control information to be embedded in the target binary image; and

25 a module for an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

58. A computer-readable storage medium storing a program for executing an image processing method for processing an input image, said storage medium comprising:

5 a module for an extraction step of reading a
document image and extracting an outline of the image;

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a module for a step of obtaining an average of
pattern scores of an image that corresponds to the
outline;

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10 a module for a difference calculation step of
obtaining a difference between a reference-pattern
score, which is based upon a sum total of distances
between a first principal component direction of a
reference pattern and the standard vector, and the
15 average of pattern scores; and

a module for a detection step of detecting control information, which has been embedded in the document image, in accordance with the difference obtained by the module for said difference calculation step.

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59. A computer-readable storage medium storing a program for executing an image processing method for processing an input binary image, said storage medium comprising:

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25      a module for a calculation step of calculating a
      pattern vector of a target binary image;
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a module for an arithmetic step of calculating a correlation coefficient between the pattern vector calculated at said calculation step and a reference-pattern vector;

5 a module for an input step of inputting access
control information to be embedded in the target binary
image;

a module for a moving step of moving feature space of the pattern vector in accordance with the access control information, which has been input by the module for said input step, in such a manner that the correlation coefficient that has been calculated by the module for said arithmetic step will fall within a predetermined range; and

15 a module for an altering step of altering the
target binary image based upon a result obtained by
moving the vector space of the feature quantity.

60. A computer-readable storage medium storing a
20 program for executing an image processing method for
processing an input image, said storage medium
comprising:

a module for an extraction step of reading a document image and extracting an outline of the image;

25 a module for a step of obtaining a pattern vector
of an image that corresponds to the outline;

